IDENTIFICATION OF LONG TERM LEARNING OUTCOMES AND OPPORTUNITIES FOR IMPROVEMENT FROM AN INTERDISCIPLINARY COURSE IN ARCHITECTURE, ENGINEERING AND CONSTRUCTION

A Thesis

by

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ABSTRACT

This longitudinal study reports on lessons learned from interdisciplinary courses between architecture and construction science with a mix of graduate and undergraduate students taught at Texas A&M University at College Station, comparing lessons learned from past research in interdisciplinary studies in the architecture, engineering, and construction (AEC) curriculum with former student's perception 11-16 years after graduation.

Previous research on learning outcomes from interdisciplinary AEC curriculum identify teamwork, mutual respect for other disciplines, real world understanding, collaboration, coordination, time management as the most important skills learned. This study analyzes the impact of the above said outcomes and learning on the former students over the years of experience in the industry.

For the purpose of this study 19 survey responses were collected from former students who are currently a part of the industry, from fall semester 1999 and fall semester 2003. A quantitative and qualitative analysis of the data reveals that former students still highly value the skills of working in a team, the importance of collaboration and interdisciplinary understanding. They also included additional learning outcomes such as valuing the opinion of others and integrating as a team early on in the project. Although the number of responses was statistically limited,

they nevertheless suggest there is value to such interdisciplinary courses in the AEC curriculum for those who practice afterward in the building industry, and that this topic warrants further study.

DEDICATION

This thesis is dedicated to my grandparents to whom I owe everything in my life.

Thanks to my *late* grandfather T.S.Srinivasan and grandmother S.Saraswathi.

Love you both.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Zofia Rybkowski, and my committee members, Dr. José L. Fernández-Solís, Professor George J. Mann for their guidance and support throughout the course of this research. I would also like to take this opportunity to thank Prof. Dr. Anat Geva, Prof. Dr. John Bryant and *Late* Dr. James Smith for their insights about this research project.

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Most importantly, thanks to my father Kalyanaraman and mother Padma for believing me right from my childhood, trusting my decisions and standing by my side at all times of my life. Thanks to my in-laws Sekar and Rajasri, Harish and Vinaya for being a strong source

of support. Thanks to my dearest sister Nandita who has been a source of enthusiasm and immense positive energy to keep my work going.

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NOMENCLATURE

AEC	Architecture, Engineering and Construction
AIS	Association for Interdisciplinary Studies
ARCH	Architecture
BEA	Bureau of Economic Analysis
COMG	Construction Management
CM @ RISK	Construction Management at Risk
COSC	Construction Science
DB	Design Build
ENDS	Environmental Design
GDP	Gross Domestic Product
IPD	Integrated Project Delivery
OEAC	Owner, Engineer, Architect, Contractor
WSU	Wayne State University

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1. INTRODUCTION

1.1 Background of Problem

According to the US. Bureau of Economic Analysis (BEA, 2014), the construction industry in the US added 652.7 billions of dollars value towards the nation's Gross Domestic Product (GDP). Construction is one of the primary sectors that has a major contribution in the economic growth of any nation. By nature the construction industry requires lot of collaboration with other industries. In Architecture, Engineering and Construction (AEC) industry, success of a project is largely dependent on interdisciplinary collaboration. Success is a very subjective factor. Majid (2006) stated that, a successful construction project is one which is completed on time, within budget, in accordance with specifications and to the stakeholders' satisfaction. Nguyen et al., (2004) identified "competent and multidisciplinary project team" as one of the important component of the five critical factors that affects a construction project's success. From the above stated facts, the industry may be expected to be a harmonious mixture of different disciplines. However researchers such as Gonzales (2006), Zollinger and Leary (2005) have quoted in their paper that there are more litigations in the construction industry's history than ever before. Also, the industry is faced with problems due to lack of trust and collaboration, ineffective communications, lack of planned thinking which in turn affect the stakeholders relationship (Elmarsafi 2008). The interaction between Owner, Architect, Engineer and Contractor (OEAC) impacts a project's success.

Today, various project delivery methodologies like Design-Build (DB), Integrated Project Delivery (IPD), Construction Manager at Risk (CM at Risk) and other IPD-like delivery methods are trying to bring in a more collaborative approach between different stakeholders of a project, in order to make construction projects better with respect to cost, quality, time, safety and morale. To meet the demand and challenges of the AEC industry, an interdisciplinary approach to the AEC curriculum becomes vital (Irizarry, Meadati, & Gheisari, 2010). Although many research projects on identifying learning outcomes from interdisciplinary courses have been carried out, not many research work was identified with respect to the amount of learning retained by students over the years and how it contributes to their career and the industry. For this reason, it was imperative to identify the learning outcomes that the former students value the most and make necessary changes to future interdisciplinary courses in the AEC field in a way that it would benefit the industry.

1.2 Problem Statement

Over the past 100 years, the design and construction industry have become the most fragmented industry with various stakeholders involved in a project. Construction delivery methodologies have been constantly evolving ever since master builder model of Ancient Greece (Jackson, 2010). According to Smith et al., (2012), newer project delivery methodologies such as DB, CM at Risk, IPD and others, answers to current trends in industry and emphasize more on collaborative and integrate project participants.

However, Lichtig, (2006), states that the stakeholders work in isolation with no actual sharing of collective wisdom. Implementation of IPD methodology has also not completely helped in resolving issues, based on lack of trust and collaboration among stakeholders in the construction industry.

Problem: Past research identifies the need for an AEC curriculum that replicates the industry level collaboration and dependency on other disciplines (O' Brien, 2003). Outcomes from particular interdisciplinary courses have been identified. However not many studies have been carried out to see if the learning outcomes are retained by the students over the years of practice in the industry or how it affects their career.

1.3 Research Objectives

This research is an exploratory study to identify long term learning outcomes from interdisciplinary course in an Architecture, Engineering and Construction (AEC) environment taught at Texas A&M University and suggests opportunities for improvement.

1.4 Significance of the Study

Time and again researchers like Russell et al., (2007), Edwards (2012), Noor (2010), Wan et al., (2012) have brought out the fact that, companies have more interface to manage: today due to privatization, and involvement of international firms, professionals and practices from different countries, construction. This newer dimension of construction industry has brought in new challenges for the AEC education as well. O' Brien (2003);

Boyer and Mitgang (1996) in their report have mentioned that the construction industry is ill- equipped with integrative knowledge and communication skills across disciplines. Suggested AEC curriculum needs complete exploitation of interdisciplinary potential to serve society's needs. According to Chan et al., (2014) many employers feel that most college graduates do not possess generic employability skills identified by researchers Edwards, (2012); Lamb et al., (2010); Russell et al., (2007); The Gallup Organization, (2010) such as communication, negotiation, teamwork, inter-disciplinary working, planning, decision making and problem solving abilities. In contrast Chan et al., (2014), has also identified that students participating in these collaborative learning environment enhanced their academic knowledge and learned professional skills. By identifying the outcomes retained by former students from these interdisciplinary courses in the AEC curriculum, such courses in the future can be modified in a way that it adapts to the current needs of the industry.

2. LITERATURE REVIEW

2.1 “Interdisciplinary”- Definition

The term “Interdisciplinary” though more frequently used in the twentieth century, shares its roots in the Greek philosophy (Augsburg, 2006). Klein (1990) states that the “ideas of unified science, general knowledge, synthesis, and the integration of knowledge” were the starting point of the concept of interdisciplinary. Interdisciplinary programs were developed, where traditional disciplines were unable to address problems independently. Newell & Green (1982), defined interdisciplinary as “inquires critically drawn upon two or more disciplines and which led to an integration of disciplinary insights.” There is often a misunderstanding between “multidisciplinary” collaboration and “interdisciplinary” collaboration. Borrego and Newswander (2008) highlighted that, in multidisciplinary collaboration the knowledge gained remains unchanged at the end of the collaboration, whereas in an interdisciplinary collaboration, participants work hand-in-hand to repeatedly integrate knowledge and methods. Figure 1 graphically represents the above statement,

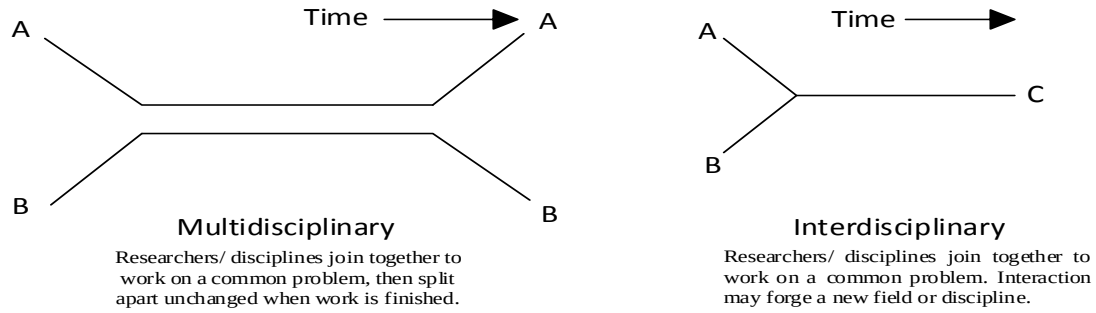

Figure 1: Multidisciplinary versus interdisciplinary collaboration (reprinted from Borrego and Newswander (2008)).

Also, Bradbeer (1999) and DeZure (1999) described multidisciplinary as an additive process while interdisciplinary as a synthesis. Apart from adding new content from different fields, interdisciplinary learning has the ability to promote understanding and integrate new values and approaches to define and solve the problem (Richter & Paretti (2009)).

2.2 Interdisciplinary Studies a Timeline

Figure 2 shows the time of major events in the field of interdisciplinary studies in general and interdisciplinary studies with respect to AEC curriculum. Association for Interdisciplinary Studies (AIS) at Oakland University, since its' founding in 1979 has encouraged interdisciplinary studies across all academic fields and subjects (Klein, 2006). The book, "The Interdisciplinary Curriculum: Design and implementation" by Jacobs (1989), illustrated a variety of methods to integrate into the curriculum. The book describes choosing appropriate criteria for providing successful integrated curriculum. It

also details a step-by- step approach to integration, beginning with selection of an organizing center to frame a matrix of activities, for developing integrated units of study. Researchers Newell and Klein, who have been presidents of the AIS in the past, have immensely contributed to the research in the field of interdisciplinary studies and curriculum design. Longitudinal study, which Newell (1990) achieved with former students from Wayne State University (WSU), stated that students were able to 'see all sides of the story', 'appreciate other's perspective', understood that each person's decisions was not final and also felt confident about a wide range of subject apart from their major. A study by Orillion, (2009) identified student outcomes from an interdisciplinary curriculum in general education. Orillion, (2009) findings suggested that the learning outcomes and their relationship with interdisciplinary curriculum is intervened by the institutional culture. Students with interdisciplinary program experience acquire integrated viewpoints and strategies that are solution focused.

2.3 Interdisciplinary Curriculum in AEC

In comparison to AEC industry in Asia and Europe, the US industry is highly fragmented (Howard et al, 1989). Howard et al, (1989) also noted that fragmentation occurs throughout different stages of construction project and affects the overall productivity of the industry. Toor and Ogunlana (2010), stated that factors relating to designers, contractors and consultants are the main cause for delay in the construction project in Thailand. With current advancements in the construction industry it is imperative that curriculum embraces new methods to improve productivity, mitigate litigations, and to

deliver the best to satisfy clients, Shelbourn (2007). In conjunction to the situation, the Boyer and Mitgang (1996) in their report, stated the need to fully exploit the interdisciplinary potential for architectural education and practice. This resulted in many research projects throughout the world to include interdisciplinary curriculum in the AEC industry. A few research works that marked milestone events in the interdisciplinary curriculum of AEC are identified in the Figure 2.

Table 1 discusses the findings of different research papers.

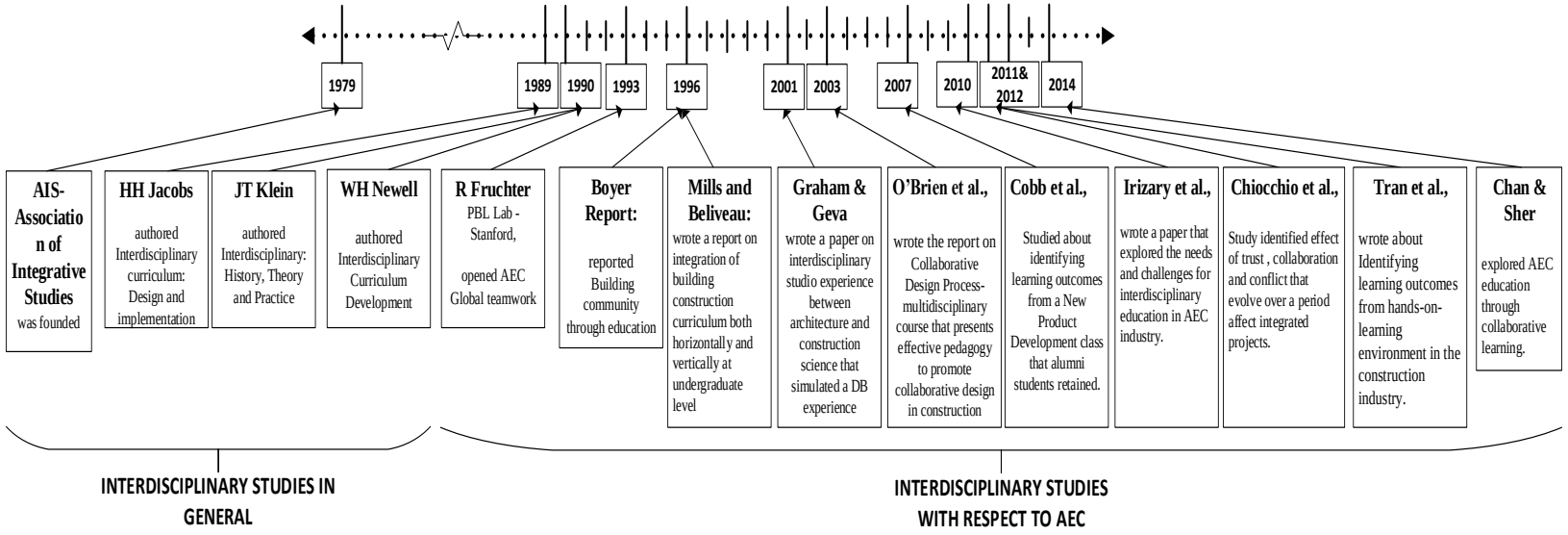

Figure 2: Timeline of important activities in the field of Interdisciplinary studies in general and Interdisciplinary studies in AEC curriculum.

Table 1: Past research about AEC interdisciplinary studies and their findings

Year	Author	Paper	Research finding
1996	Boyer, E.L and Mitgang, L.D	*Building Community: A new future for Architecture Education and Practice.*	Identified seven priorities to be included in system of architectural education and suggested a better integrated curriculum with knowledge both within and outside the architecture discipline.
1999	Mills, T.H and Beliveau, Y.J	*Vertically integrating a capstone experience.*	Integrated lab experience changed course objectives from task management into people management. Enhanced leadership qualities and performance.
1999	Fruchter, R.	*Architecture/ Engineering Construction teamwork: A collaborative design and learning space.*	Described ongoing research efforts to integrate an AEC curriculum and use IT as a medium of interaction.
2000	Kalay and Black	*Berkeley's A/E/C Collaborative Design Studio*	Identified collaborative problem solving technique as pedagogical issue.

Table 1: continued

Year	Author	Paper	Research finding
2001	Graham, C. W and Geva, A.	*Evaluation of an interdisciplinary studio experience to teach architecture and construction science students the design- build project delivery method*	Demonstrated the real world problem between architects and construction managers during decision making process. Suggested inclusion of more interdisciplinary studio courses to increase interaction.
2003	O' Brien and Soibelman L.	*Collaborative Design Process: An Active- and Reflective Learning Course in multidisciplinary collaboration.*	Provided feedback that multidisciplinary collaboration helped prepare students for professional practice after collaborating with people with different perspectives.
2006	Lucko	*Student-Centered Learning Environment During Undergraduate Education in Construction Engineering and Management – Developing a Construction Consulting Project*	The project outcomes listed by students from these interdisciplinary courses were: communication and teamwork. Recommendation: stronger industry involvement, relatable site and project description.

Table 1: continued

Year	Author	Paper	Research finding
2006	Holley, P.W and Dagg, C.	*Development of Expanded Multidisciplinary Collaborative Experiences Across Construction and Design Curricula*	Response from students, indicated that interdisciplinary studio courses improved mutual respect and empathy between the two programs. Restated that academia is the best place to integrate different streams.
2009	Dong, Doerfler and Montoya	*Collaborative Teaching to Create Integrated Building Envelopes*	Students' response suggested that they realized importance of members in a team "being on same page", using integrated project delivery models.
2009	Richter and Paretti	*Identifying barriers to and outcomes of interdisciplinarity in the engineering classroom*	The findings suggested 1. Lack of ability to connect interdisciplinary subjects to their own disciplines. 2. Fail to value contributions from multiple fields.

Table 1: continued

Year	Author	*Paper*	Research finding
2010	Irizarry et al.,	*The Need and Challenges for interdisciplinary education in AEC*	Concluded that interdisciplinary work environment significantly enhanced creative design solution, promoted construction related problems and sustainability.
2011	Chioccchio et al.,	*Teamwork in integrated Design Projects: Understanding the effects of Trust, Conflict and Collaboration*	Study showed that collaboration boosts the positive effect of trust and dampens the negative effect of task conflict, offering possibility to improve performance.
2012	Tran et al.,	*All Hands on Deck: collaborative building design education for architects and engineers*	Study helped understand construction rather than just drawings and provided an experience of solving real-life problems experienced by AEC industry.
2014	Chan et al.,	*Exploring AEC education through collaborative learning*	Collaborative learning enhanced academic knowledge and improved general employability skills[1].

[1] General employability skills- communication and negotiation, team working and inter-disciplinary working, planning, decision making and problem solving ability (Edwards2012)

2.4 Preliminary Research Findings

From Table 1, it can be seen that past research studies about AEC interdisciplinary coursework have often suggested that it helps the industry in terms of collaborative work. Table 2 points out to the factors identified as "perceived learning outcomes" from respective interdisciplinary courses in the AEC curriculum.

Table 2: Factors identified from literature*- "perceived learning outcomes"

Factor	No. of citing in literature
Teamwork	4
Mutual respect for other disciplines/ understanding and accepting values of other disciplines/ Trust	4
Practical scenario " real constraints"/ problem solving	3
Collaboration	3
Communication	2
Creativity	1
People management	1
Leadership skills	1

* Number of papers considered for literature review= 14

Cobb et al., (2007) at University of California conducted a research to identify the lessons retained by the former students of a New Product Development class taken one –ten years in the past to identify how it affects them in their careers. Similarly, this research would focus on confirming whether the former students who took the interdisciplinary studio

courses retain these outcomes listed. Furthermore, it aims at addressing potential for improvements in coursework.

3. RESEARCH METHOD

3.1 Aim of the Study

The aims of the study were the following:

- Identify learning objectives retained by students over years from interdisciplinary course in an AEC environment.
- Analyze the impact of these learning outcomes on their careers
- Suggest how these courses need to be improved to benefit the AEC industry.

In order to accomplish these research objectives, two interdisciplinary courses taught at Texas A&M University during the fall of 1999 and the fall of 2003 respectively were chosen for the study.

3.2 Interdisciplinary Course Description

The two interdisciplinary studio courses: fall 1999 and fall 2003, shared similar course objectives and were the two most comprehensive courses at Texas A&M University, which delivered close to industry-level collaboration needs for the project. These courses were conducted as an interdisciplinary studio between graduate and undergraduate students from Architecture and Construction Science at Texas A&M University. The course was structured in such a way that the students were formed into groups with representatives from each course. Each student in a group was assigned particular deliverables based on their major. For example, architecture students delivered the design, site planning and other architectural details while construction science students were

responsible for producing the estimates, schedule, and mechanical, electrical and plumbing package, for the project.

Fall 1999 Interdisciplinary Studio - Courses that came together for the studio in fall 1999 were ARCH 305 (Architectural Design II), COSC 325 (Environment Control Systems I), COSC 455 (Alternate Construction Delivery Systems) and COSC 689 (Special Topics). At the end of the semester each group from 1999 presented its research design and construction proposal (program, drawings and models) for "New 720,000 SF, Expansion of Children's Medical Center of Dallas" using Design/ Build delivery methodology. The project was scheduled for an entire semester from August 1999- December 1999 (4 months). 73 students were divided into nine groups with designers, construction science students and environmental design students in each team. (Appendix A and B)

Fall 2003 Interdisciplinary Studio – Courses that worked together in fall 2003 were ARCH 405 (Architectural Design III), COSC 429 (Interdisciplinary Capstone) and COSC 648 (Graduate Capstone). Each group from fall 2003, prepared a single source contract package for an owner who wished to set up an "8000- 10000 SF, All Faith Worship Place in either of 4 sites: Palo Duro Canyon, Sabine National Forest, Alpine or Port Aransas, in Texas." The project was scheduled for 10 weeks from October 2003- December 2003. 35 students were divided into seven groups with five members each- two architecture students and two construction science undergraduates and one construction science graduate student. (Appendix C and D)

Although no formal course objectives were posted for the interdisciplinary course delivered in fall 1999 at Texas A&M University and as the two courses were similar, the overall objective of these courses can be summarized, from the interdisciplinary course that was offered by Anat Geva, PhD, a professor in the College of Architecture and James Smith, PhD, from Construction Science department, in the fall of 2003 and had published objectives in their syllabus. Also, each of the above mentioned independent courses had separate objectives:

- To understand the design process;
- To understand the interaction of culture and environment on built form;
- To design a project within programmatic requirements and constraints;
- To understand the process of a design-build project;
- To clearly communicate design ideas;
- To work in teams.

3.3 Data Collection

The data collection process for this research was initiated by gathering a list of students who took the interdisciplinary AEC course from Professors George Mann and Anat Geva, who were the respective faculties for the fall semester of 1999 & 2000.

Number of students who graduated from Department of Construction Science and Architecture in the fall of year 1999 were 62 and 77 respectively, comprising both undergraduates and graduates. The fall 1999 class under consideration, comprised a total

of 73 graduate and undergraduate students from the departments of Environmental Design (ENDS), Architecture (ARCH), Landscape Architecture (LA) and Construction Science (COSC). (Table 3)

Table 3: Classification of students based on their disciplines – fall 1999

	ENDS (B)	ARCH (M)	COSC (B)	COSC (M)	LA (B)	Unknown	TOTAL
Number of students	30	7	15	7	8	6	73

(B)- Bachelor's, (M) - Master's

Number of students who graduated from Department of Construction Science and Architecture in the fall of year 2003 were 49 and 66 respectively, comprising both undergraduates and graduates. The fall 2003 class considered for this research, comprised a total of 35, graduate and undergraduate students from the departments of Environmental Design (ENDS), Architecture (ARCH), and Construction Science (COSC). (Table 4).

Table 4: Classification of students based on their disciplines – fall 2003

	ENDS (B)	ARCH (M)	COSC (B)	COSC (M)	TOTAL
Number of students	12	5	11	8	35

(B)- Bachelor's, (M) - Master's

Of the 108 students, contact information of 93 students was identified using the Aggie Alumni Network, and recruiting emails with the survey link were sent. An informed consent form was included as a part of the online survey, which the participant had to attest to continue with the survey.

(Appendix E) The survey was divided into five sections, educational background, professional background, interdisciplinary course(s), career implication and retrospection. While educational and professional background questions were primarily focused on understanding the demographics of the respondents, the section on interdisciplinary course(s) was based on respondent's experience about their course of the past. The section on career implications and retrospection focused on identifying the learning outcomes from the course and its impact on each of the survey participants' careers. The participants were asked to suggest areas of improvement in the future courses

The survey was kept active for a period of 21 days, during which 23 responses were recorded, gaining a response rate of 24.73% (23 out of 93 surveys). On the basis of percentage completion of the survey, three responses with less than 50 % completion were rejected. One of the respondents stated, "No, I did not take the course," and quit the survey. This has resulted in 19 complete responses (completion rate >80%), based on which the conclusions of this study are drawn. (Figure 3)

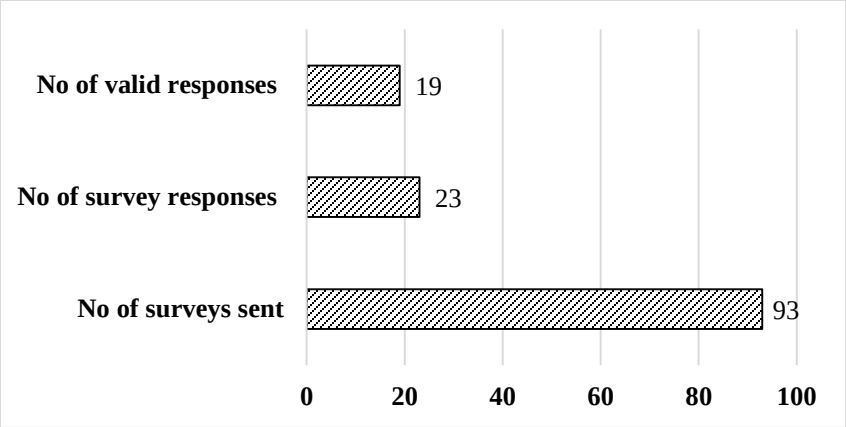

Figure 3: Survey statistics

3.4 Data Analysis

Data collected from these survey responses were systematically categorized based on their section in the survey.

- The demographics section classifies the responses based on respondents'
    a. major when they took the course and year in which they took the course;
    b. maximum level of education and current role in career;
    c. years of experience in the industry.
- The section on the interdisciplinary course(s) discusses the experience of the respondents from the particular studio. It elaborates on the course structure, project team organization, schedule of meetings, course challenges, industry involvement, and learnings from the course that the former students cherish.
- The career implication section based on the ranking given by the alumni prioritizes "perceived learning outcomes" from the interdisciplinary course that impact their

career. It also illustrates few examples of respondent statements on these outcomes.

- The retrospection details respondent's exploration about the course outcomes. The former students discussed factors of the interdisciplinary courses that functioned well and those that needed to be improved or included in the future courses to suffice the need of the industry.

The organized data then was analyzed using both quantitative and qualitative methods.

- The demographics section was used to frame an idea about the survey participant's background and how their career roles affect their perception about the interdisciplinary course.
- Responses from interdisciplinary course section were analyzed in relation to responses from career implication to arrive at a conclusion about the actual learning outcome that the former students retain from the interdisciplinary course.
- Data from retrospection are analyzed to suggest course improvements for future interdisciplinary courses.

3.5 Assumption

For successful completion of this project a number of assumptions were made. They are as follows:

- The respondents from the departments of architecture and construction management from the fall semesters of 1999 and 2003, who took these

interdisciplinary studio courses, remember and retain the knowledge gained from their course work.

3.6 Limitation

- The population size considered for research was 108 former students (total number of students from the two classes). The final sample size was only 23, which is not a statistically significant sample size to conclude with any confidence level.
- There were only eight landscape architecture students in the fall 1999 and no responses from this discipline was recorded. Results may have varied if at least one response was recorded from this major.
- The research does not consider participant's grades in the particular course work as a factor that affects their perception about the course outcomes.

3.7 Delimitation

- This case study research is restricted to finding the long-term outcomes only from the two interdisciplinary courses taught at Texas A&M University in the fall 1999 and fall 2003.
- This research is bounded within the scope of the interdisciplinary studio course.

4. RESULTS AND ANALYSIS

4.1 Demographics

Fourteen former students from fall 1999 and five former students from fall 2003 took the online survey (Figure 4). Out of which nine responses (22%) were from construction science major and 10 (19%) were from environmental design/ architecture major (Figure 5). Of the people who responded, seven are pursuing their careers as contractor/ sub-contractors, 5 are designers/ architects, two are owners, two are project managers, and 3 have other professions (Figure 6). It was also noted that while 31% of the respondents (6 out of 19) have more than 16 years of experience, 47% of them (9 out of 19) have 11-15 years of experience in the field of construction and the remaining 22% had less than 10 years of experience (Figure 7). It can also be observed that 14 of 19 respondents had master's degree (Figure 8). The survey responses included 9 master's students and 10 undergraduate students who were a part of these interdisciplinary studio (Figure 9).

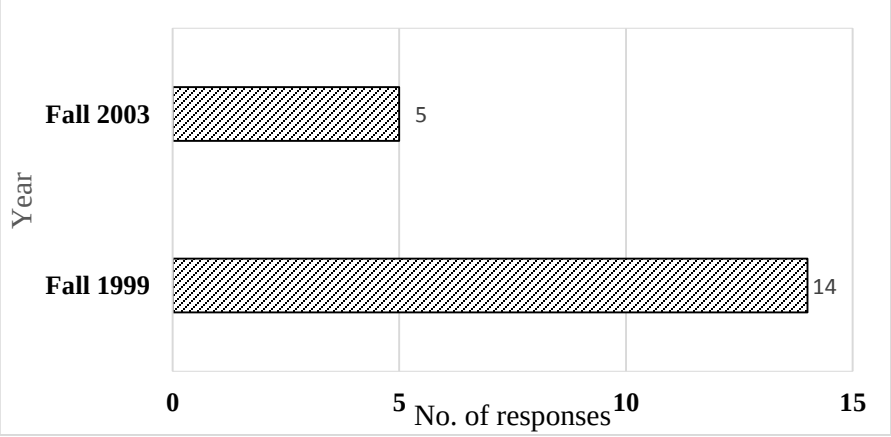

Figure 4: Number of respondents from fall 1999 and fall 2003.

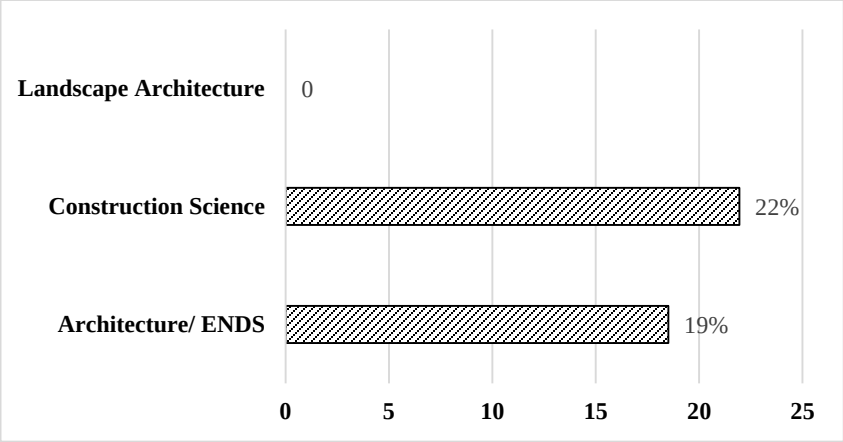

Figure 5: Respondent classification based on discipline

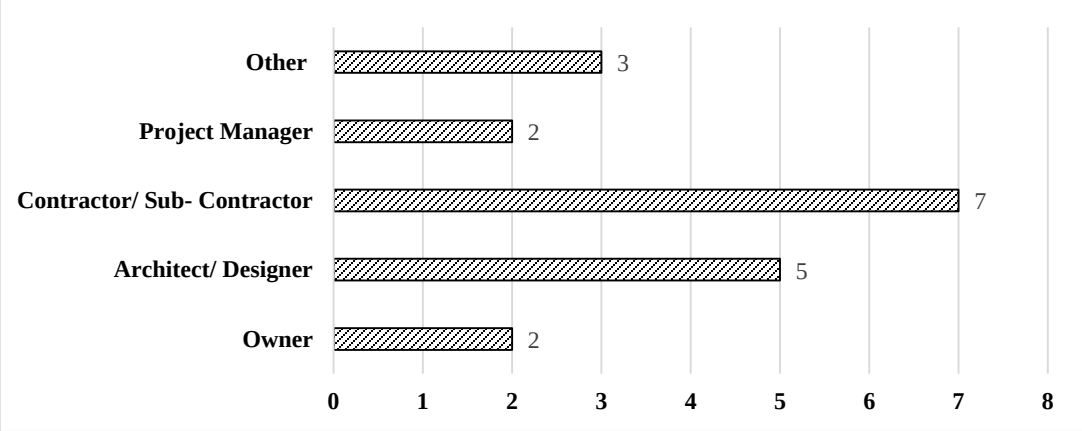

Figure 6: Respondents' current role in their career

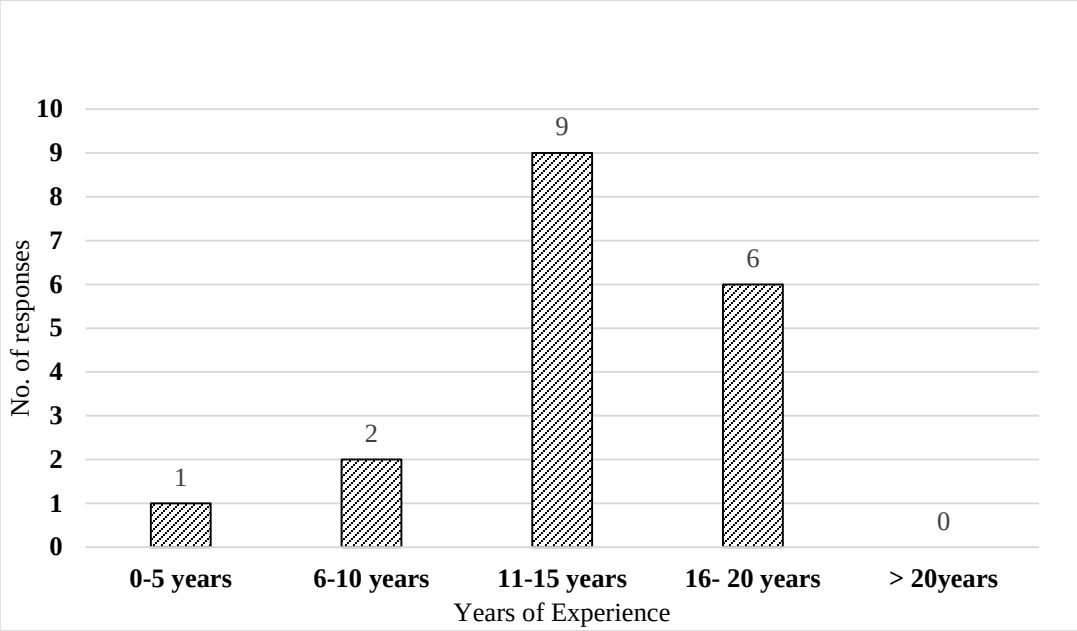

Figure 7: Respondent's years' experience in AEC industry

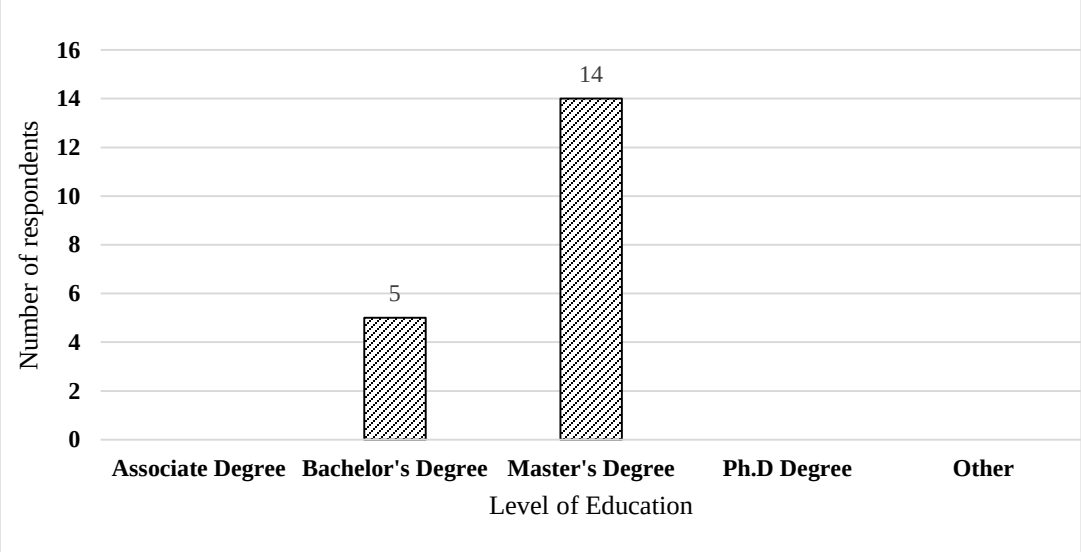

Figure 8: Maximum level of education of the respondents

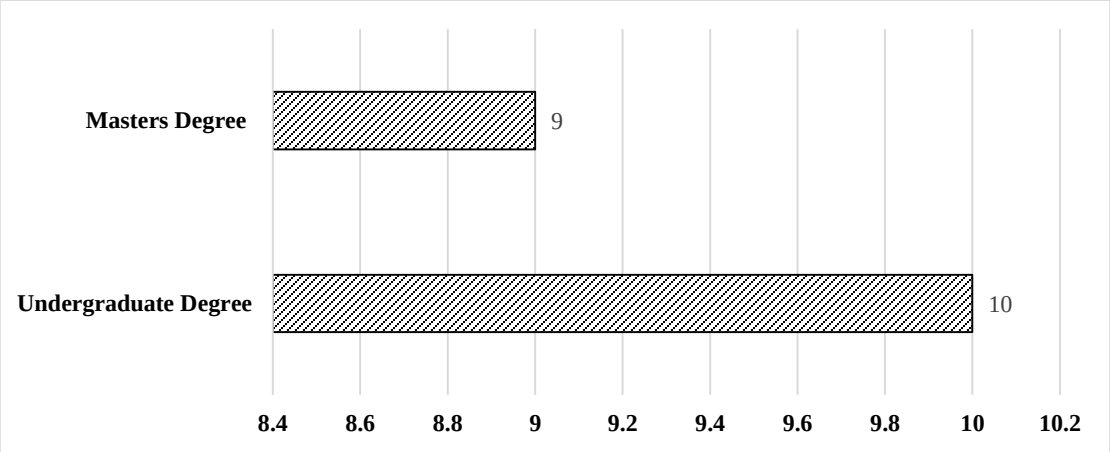

Figure 9: Respondent classification based on their program levels while they took the course

4.2 Interdisciplinary Course

This section focused on former students' experiences of the course that was taken in the past. About 50% (+ or - 2 %) respondents replied with conviction for questions very specific about the course, such as, "How were the project's teams determined or How often did you meet as a team, outside of class to work on the project?" It was found that most often students from one discipline formed a group based on their compatibility, and professors teamed them into one complete design group at random. A few of the responses were:

"I believe within each class everyone was able to choose a partner and then the professors paired groups from each class to form a "full" design and construction team"

"It was pre-determined by the professors and the expectation was that the Master's students would play the role of mentoring to the undergraduate student"

This scenario is analogous to that of the industry where a group of architects, contractors, sub-contractors unfamiliar with each other, is assembled based on the business needs. 10

out of 19 alumni stated that they met once a week as a team outside their class hours and worked on the project. Only two out of 19 replied that their teams either never met or met only once monthly. Others either do not remember the frequency of the meetings, or stated that they met at their convenience.

Table 5: Comparative matrix showing the comfort level of respondents about working in teams in the INITIAL AND FINAL stages of the project, where 1= not comfortable and 5= very comfortable.

RESPONDENT #	INITIAL	FINAL	Δ
1	4	4	0
2	5	4	-1
3	2	2	0
4	4	4	0
5	4	4	0
6	1	1	0
7	5	5	0
8	2	5	+3
9	1	4	+3
10	4	4	0
11	2	4	+2
12	4	4	0
13	2	4	+2
14	4	4	0
15	2	5	+3
16	2	5	+3
17	5	5	0

Table 5: continued

RESPONDENT #	INITIAL	FINAL	Δ
18	4	4	0
19	5	5	0

INITIAL- refers to the "value" given to the attitude at the start of the project
FINAL - refers to the "value" given to the attitude at the end of the project
Δ - refers to the difference in values between FINAL and INITIAL
All values were collected in the survey.

From Table 5, it can be seen that 12 out of 19 times the respondents claimed that they did not realize any change in their opinion towards working as a team, as 11 of these former students stated they were either comfortable or very comfortable from their initial phase of the project. Only one of the response stated the person was not comfortable from the initial to the final phase, which could be considered an outlier. Both positive and negative changes in the scale are also observed. These could be attributed to the frequency with which the teams met, strategy they used and the challenges they faced to work as a team. 14 of 19 respondents stated they used "divide and conquer" as a strategy to approach the project. One of the respondent was quoted saying,

"The architecture students created the design and the construction students developed the budget and schedule. We met daily either as a team or individually to review the progress of their tasks. The architect students provided input to the cost and schedule and the construction students gave the architect students comments about construction. I guided them as a team to develop a holistic or integrated design and construction solution."

12 out of 19 respondents (63% of respondents) said they did face challenges working as a team. 6 out of those 12 respondents claimed that schedule clash and meeting time was their biggest challenge. Though the course was an interdisciplinary studio, all the disciplines met at different time for their classes, which made the team meetings during class hours difficult. Other challenges included:

- personality conflict;
- communication difficulties;
- lack of authority or leadership;
- lack of mutual respect among disciplines.

Table 6: Tabulation of learning outcome terms explicitly used by survey respondents on survey question 19. The terms describe the five most important learning outcomes students felt they obtained from the interdisciplinary studio course.

No.	Skill/ Learning outcome	No. of Responses	Percentage of Response
1	Teamwork	9	11.8
2	Collaboration	8	10.5
3	Communication	6	7.9
4	Interdisciplinary understanding	6	7.9
5	Coordination	4	5.3
6	Client interaction- Delivering the need	4	5.3
7	Time management	3	3.9
8	Leadership Skills	3	3.9

Table 6: continued

No.	Skill/ Learning outcome	No. of Responses	Percentage of Response
9	Creativity	3	3.9
10	Accountability	2	2.6
11	Early integration as team/ early communication	2	2.6

The learning outcomes have been noted and arranged in Table 6 with most quoted response being teamwork and least quoted response being early integration or early communication.

It can be observed that nine out 19 former students' ranked "teamwork" as their most important skill learned from the interdisciplinary studio course. "Collaboration" ranks second with eight out of 19 responses. The other commonly perceived learning outcomes of an interdisciplinary studio were communication, interdisciplinary understanding, coordination and time management. A few of the other important factors that were identified explicitly and not found in the literature reviewed include:

a. Valuing others opinion equally;
b. Early integration as a team;
c. Client interaction/ delivering the need;
d. Accountability;

e. Practical approach;

f. Work prioritization and delegation of work.

4.3 Career Implication

To supplement the findings from the above open ended discussion, alumni students were asked to rank "the perceived learning outcomes", based on the impact on their career (Figure 10). These outcomes were quoted from literature studies and includes:

- Teamwork;
- Communication,
- Collaboration;
- Coordination;
- Trust building;
- Negotiation skills;
- Leadership skills;
- People management and
- Time management skills.

With 78% of the respondents ranking "teamwork" as "highly beneficial", it may be regarded as the most important learning outcome retained by alumni over the years. "Communication" and "time management" skills were the other factors that former students had ranked second "highly beneficial" (68%), based on the impact on their career. "Creative thinking," "Trust building," "Leadership" and "People management" skills were

valued equally “highly beneficial” by 55 % of respondents. It can be observed that only 31% respondents ranked “negotiation” skills to be highly beneficial, in terms of its impact on their career.

Table 7 reassures that each of the learning outcomes as discussed in the literature, with an average rating over and above “4”, indicates that former students realize value of these skills even in their career. About 68% of respondents said their day-to-day work involves collaboration, co-ordination and teamwork, with various other fields and stakeholders, on a larger scale. As such the interdisciplinary studio was their first experience at a similar level, which simulated the professional reality.

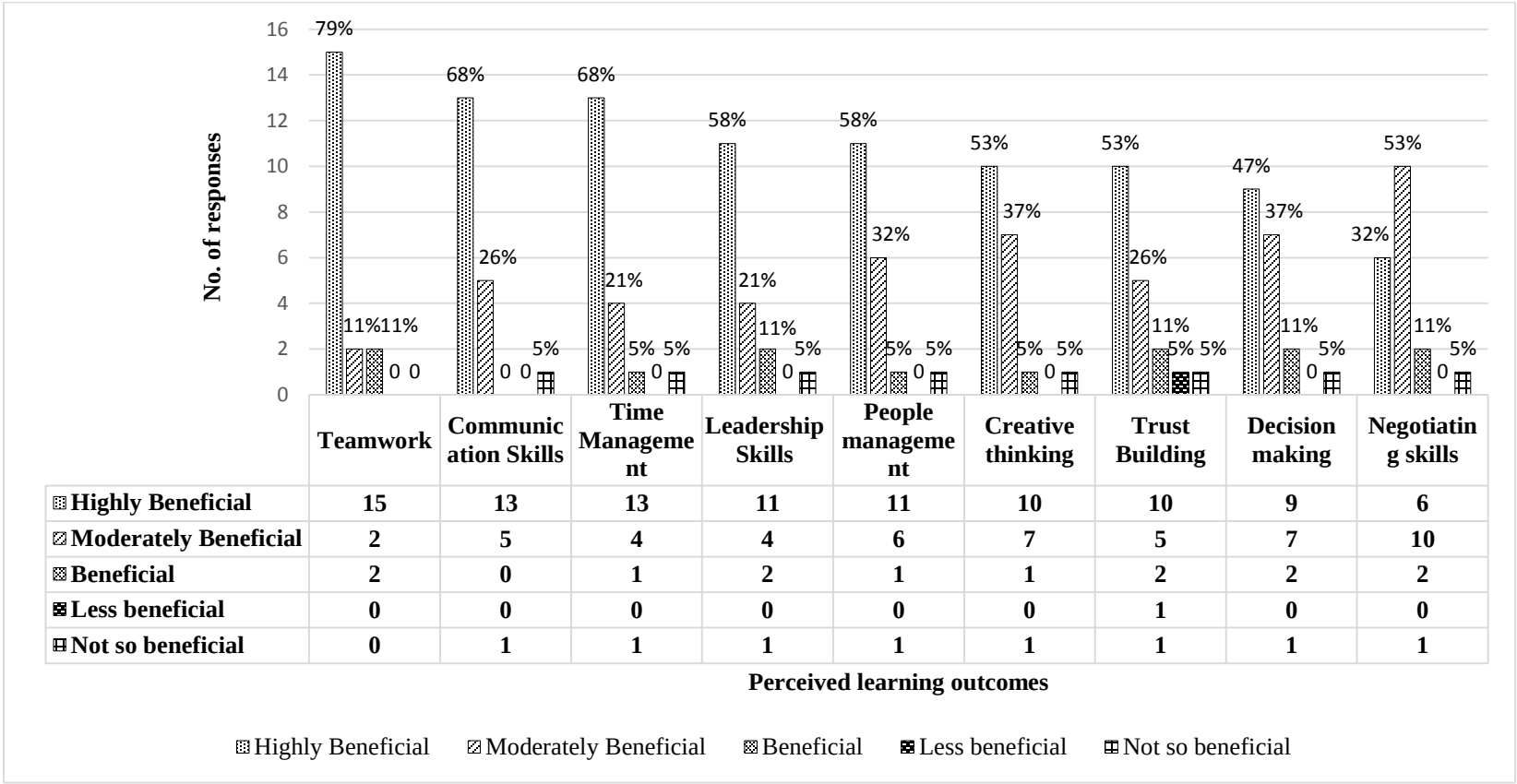

Figure 10: "Perceived learning outcomes" and level of impact on individual's career arranged in the decreasing order of priority %

Table 7: Former student's ranking on "perceived learning outcomes"

No.	Learning Outcome	Mean (1-5 scale)	Standard Deviation	Example Response
1	Teamwork	4.68	0.67	*"As a consultant, I have to encourage teamwork to ensure the loudest voice doesn't always win"*
2	Creative Thinking	4.32	1	*"I consistently have to be creative in how I communicate a problem or solution to my client"*
3	Trust Building	4.16	1.17	*"Reliant upon each other's performances in order to win. Deadlines, completion of responsibilities."*
4	Decision Making	4.21	1.03	Decision are to be made about, *"Impacts of individual's performances and how it played into the overall result."*

Table 7: continued

No.	Learning Outcome	Mean (1-5 scale)	Standard Deviation	Example Response
5	Negotiating Skills	4.05	0.97	-
6	Leadership Skills	4.33	1.08	*"Keeping the team focused and on task. Making commitments."*
7	Communication Skills	4.53	0.96	*"Communication failure is number one project killer"*
8	Time management	4.47	1.02	*"I work on very complex tasks, and when no clear deadline exists I have to work very hard to manage my own time and progress"*

Table 7: continued

No.	Learning Outcome	Mean (1-5 scale)	Standard Deviation	Example Response
9	People management	4.37	1.01	*"I need to use all resources available to me including people to get the job done";* *"Interacting with others who may be initially shy, see things from a different perspective and not realize your point of view and what it takes to do your job."*

4.4 Retrospection

When former students reported on their experiences during the course and about its outcomes, one of the respondent recalled saying it was one of their few experiences to work as design and construction team together. It helped them work with all kinds of people from various backgrounds by building trust. One of the alumnus/ alumnae stated this course was his/ her foundation from which their career progressed.

Former students emphasized that the course offered a holistic idea about the construction industry and helped them comprehend the same:

"Yes, I think the overall experience gave me a realistic picture of the "real world" and it prepared me for what was to come;"

"I learned early on that I wanted more from my career than to just be an architect. I wanted to learn and experience everything to do with the built environment. As a developer who owns the projects, I can now say it was well worth the work. I know my projects intimately and as a result, they are a huge success;"

"I always push design/construction integration early in projects. The real skill is not letting one dictate the direction of the other."

There were two responses out of 16 that stated this course did not offer them anything new, but was a platform to experience a real world situation. However, they mentioned it was difficult to replicate daily challenges in a classroom atmosphere.

4.5 Recommendations from Former Students

Former students were given a chance to express their views on providing these interdisciplinary courses in the future semesters. They were also asked to do a plus- delta analysis to suggest the opportunities for improvements in such courses. 94% respondents felt it was necessary to have more of such interdisciplinary courses.

"Coordination is a HUGE part of what we do in our industry and exposure to that in college is extremely important."

With regards to areas of improvement in future interdisciplinary courses in AEC field, one of the main suggestions was to work on real projects, including the involvement of mentors from firms and industry. Three respondents mentioned the need to adapt real world scenarios in future courses. One of the responses stated:

"No change to my experience. Great all around and one of my favorite courses in college. Continue interaction of real projects with actual projects and needs. So much better than working in the hypothetical"

The other concern was about scheduling the classes in such a way that the teams got time to meet and work during class hours, have an hour or two every week of integrated class. As mentioned earlier about 50% of respondents mentioned schedule clash as the main challenge they faced as a team. In order to make the interdisciplinary course more suited for industry needs, including leadership skills in the course design, adding scope for more creativity and making such interdisciplinary courses mandatory were few other suggestions that evolved from respondent's answers. One former student quoted,

"Some of the courses can be made mandatory so you have the benefit of being to work across disciplines when you are out in the real world or such that it helps you effectively collaborate."

One of the respondents had suggested inclusion of "risk management and conflict management" as a part of these interdisciplinary studios in the future to add value.

As stated earlier, most of these former students are contractors/ subcontractors, project managers and designers with 11- 15 years' experience, who still remember and retain the values learned from a course taken at least 12 to 16 years back.

5. DISCUSSION AND FUTURE WORK

- It was observed that number of respondents who graduated 16 years ago from the group of fall 1999 was 22% (14 respondents out of contacted 61 former students) while those who graduated 12 years ago from the batch of fall 2003 was only 15% (5 respondents out of 32 contacted former students). It was also observed that 11 out of 19 respondents were able to recollect the details of the project they worked on in the course. Furthermore, there were six respondents from fall 1999 who stated about the involvement of industry names in the project, while only two from fall 2003 who stated of and inclusion of real world scenarios in their projects. Considering the above statement and analyzing the suggestions given by the former students for course improvements, it may be inferred that due to working on a real time project and industry involvement, fall 1999 former students response rate has been higher in comparison to fall 2003 batch. This might indicate that inclusion of industry mentors and volunteers may be a prime factor for achieving desired outcomes from these interdisciplinary courses in AEC curriculum in the future.
- Further observations indicate that apart from the common "perceived learning outcomes" such as "teamwork", "collaboration", "coordination", former students have suggested "valuing other's opinion," "value of early integration between designers and construction," "accountability" as course outcomes. Two responses suggested, including objectives that involve risk management, conflict

management skills in such interdisciplinary courses. It may be understood from the values retained by former students and their suggestions, that the curriculum for interdisciplinary courses in AEC needs to concentrate on satisfying the industry needs.

- For future research in this field, it would be interesting to identify students from other disciplines, such as business majors, that need to collaborate in the building industry with architecture and construction science to achieve success in a project. Also it would be a challenge to identify and analyze the course outcomes of interdisciplinary courses taught in the AEC field that include architecture, construction science, and business majors.

6. CONCLUSION

The survey analysis reported in this research provides a preliminary investigation of the lessons learned and retained by former students from the interdisciplinary studio courses that were taught at Texas A&M University in the fall 1999 and fall 2003. Former students in the construction industry have valued the "perceived learning outcomes" from the literature studies, namely teamwork, communication skills, creative thinking, trust building, etc., as the most important aspects of the interdisciplinary studio courses.

The former students analyzed the interdisciplinary courses through their career experiences and identified factors such as "valuing other's opinion equally," "early integration as a team," "accountability," "work prioritization" and "delegation of work" as other important learning outcomes of these interdisciplinary courses. However, they also identified working together in a team, communication with team members, scheduling a meeting time as the challenges they faced.

Suggestions mentioned to improve the course was inclusion of real projects and engaging mentors from the industry.

63% of former students responded that the coursework had a positive effect on the strategy they adopt in their career. Three of them stated they enjoyed the course and felt it was a different experience. Two respondents quoted that it was their first experience to work with people outside their discipline, which taught them values about collaboration and

cooperation. These responses suggest that the course(s) might have had an overall positive feedback. However, one of the responses said the former student was unhappy with the course structure. The respondent felt architecture and construction science students do not go hand in hand, as there was no mutual respect between the disciplines. This respondent further added that aesthetics of design aspects were valued less and also felt an interdisciplinary course with architecture and business majors would have been better.

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APPENDIX A

Deliverables as given by Dr. John Bryant, Professor in the Department Of Construction Science, who was a part of the interdisciplinary studio handling COSC 325 in the Fall 1999 at Texas A&M University.

CHILDREN'S HOSPITAL DESIGN-BUILD PROJECT

DELIVERABLES

ITEM	DESCRIPTION	DUE DATE	BY
PARTNERING AGREEMENT	Derived from initial team-building session	15-Oct	GS
STUDY MODEL		15-Oct	DS
TEAM LOGO SHEET FORMAT		15-Oct	DS
PROJECT DESCRIPTION	Mission, vision, history of Children's Hospital; project objective; location; aerial and other photos;existing site plan	15-Oct	TEAM
DESIGN CONCEPTS		15-Oct	DS
Site Analysis			DS
Space program			DS
Space relationships			DS
Interior/exterior perspectives			DS
Block diagrams			DS
Section diagrams			DS
Structural systems[prelim]	Preliminary analysis of options		DS & CS
Mechanical systems[prelim]	Preliminary analysis of HVAC and plumbing options; research applicable codes		DS & ES
Electrical/power systems[prelim]	Preliminary analysis of power demand, source options, backup power		DS & ES
Cost estimate[prelim]	Preliminary analysis of overall project cost by CSI division		DS & CS
PROGRESS REVIEW	Review by the owner in College Station	15-16 Oct	TEAM
RECOMMENDED FORM OF CONTRACT	Options considered and justification for selected option; key contract provisior	19-Nov	GS
FINAL MODEL	40 x 40 Display quality	19-Nov	DS
FINAL PROGRAM	Design concepts refined to include recommended floor plans	19-Nov	DS
SELECT PREFERRED MECHANICAL-ELECTRICAL SYSTEMS		19-Nov	ES
Primary heating and cooling component	Size, specify and select		
Piping	Size and specify primary piping		
Mechanical room[s]	Locate and layout		
AHU systems	Size, specify, and layout[on-line schematic] for required zones		
Value Engineering	Identify changes made and why		
Primary and secondary power sources	Specify and layout		
Backup power	Determine demand, specify, locate		
CONCEPTUAL COST ESTIMATE	Refined preliminary estimate with contingencies and overall project cost Develop the cost-revenue curves and analyze cash flow	19-Nov	CS
SCHEDULE ANALYSIS	Bar chart or network; identify critical path and key activities	19-Nov	CS
VALUE ENGINEERING	Changes made and why during design process	19-Nov	CS
BID PACKAGES	Recommended packaging of subcontracts with key dates for each	19-Nov	CS
SITE LOGISTICS PLAN	Plan showing site access, laydown areas,storage, trailer sites, material delive temporary traffic, temporary signage, parking, and crane location	19-Nov	CS
PRESENTATION [IN DALLAS]	Power point presentation; every team member has a part; final boards; final model; "hard copy 'leave behind'"	8-Dec	TEAM

GS = GRADUATE STUDENT
DS = DESIGN STUDENT
CS = CONSTRUCTION STUDENT
ES = ENVIRONMENTAL SYSTEMS STUDENT

APPENDIX B

Course brief, from a poster designed for the interdisciplinary studio in fall 1999 at Texas A&M University.

Courtesy: George Mann, Professor in the College of Architecture.

Texas A&M University
College of Architecture
Founding Member of GUPHA (Global University Programs in Healthcare Architecture)

Participants:

Student "Design/ Build" Teams

Team #1
Seth Anderson
Min-Seh Seh (Korea)
Erin Goffman
Albert Mares
Patrick McCloskey
Mehrdad Nasrvar
Scott Thetford
Stuart Allison
Brooke Blaylock

Team #2
Katie Carlisle
Anjesha Kadam (India)
Philip Zoch
Keith Wilson
Gregory Paul Pinkstaff
Vickie Garcia
Brandon Barker
Ben Debelik

Team #3
Ketan Tipnis
Al Espinal
David Pellinghorn
Lauren Elford
Tyler Keen Milligan
Mesiea Maria Dorlon
(Guatemala)
Megan McAffee
Chris Eiseman

Team #4
Greg Gold
Kristen Bourg
Jennifer Washer
Jason Bragg
Josh Miller
Summer Hatfield

Team #5
Melissa Guerrero
Young Ho Ka (Korea)
Jeremy Tilley
Thomas Smith
Lawrence James McCarty
Sara Partridge
Sahkura Ratsotitha
Marc Spiegel
Marcus Aloysius Bolton
Pat Di Ghet

Team #6
Frank Moore
Kevin Bartoe
David DeLeon (1999-2000 AIA / AIA Fellow)
Carrie Greene
Akilha Jefferson
Maria Rodriguez
John Listowski
Dana Bettis
Jamie Peeler

Team #7
Joel Redman
David DeLeon
(1999-2000 AIA / AIA Fellow)
Sean Murphy
Melissa Rose-Crispin
Ed Hunt
Becky Burchfield
Dana Pechacek
Brian Warne

Team #8
Jeff South
Akshay Kini (India)
Eric Garcia
Melinda Picard
Matthew Lewis
Natalie Pere Hernandez
Eric Geppelt
James Williams

Team #9
Coki Halmon
Tushar Gupta (India)
Erika Cuellar
Noe Franco
Jesse Michael Haus
Ryan Cotton
Coty Wilson
Tommy Yetts

Department of Architecture
Professor Julian M. Gribou, Head, Department of Architecture
Debbie Franklin, Administrative Secretary
Rodney C. Hill, Associate Dean for Student Services
Professor Thomas L. McKittrick, FAIA, Assistant Department Head of Architecture
Professor George J. Mann, AIA, The Ronald L. Skaggs Endowed Professor of Health Facilities Design and Co-Project Director
Linda Fritcher, Administrative Assistant
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Tonya Hynds, Ph.D., Assistant Professor
Judy Magee, Student Worker
Rochelle Parker, Staff Assistant
Rudolfo Perez, Graduate Assistant

Department of Landscape Architecture and Urban Planning
George Rogers, Ph.D., Associate Professor, Interim Head
Lewis Knight, B.LA., MLAUP, R.LA, Visiting Assistant Professor
Harlow C. Landphair Ph.D., Professor
Ming-Han Li, Teaching Assistant

College of Architecture
J. Thomas Regan, Dean, College of Architecture & Professor
Ward V. Wells, Executive Associate Dean & Professor
Bobby Berenhausen, Communications Specialist
Kartik Gandhi, Graduate Assistant
Shana K. Hutchins, Communications Specialist

Advisory:
Joyce Aiken, Shriners Burn Hospital, Galveston, Texas
Jamal Banzi, (Morocco)
Joachim Faust, Managing Partner
HPP Architects, Berlin, Cologne, Dresden, Dusseldorf, Frankfurt, Hamburg, Leipzig, Munich, and Stuttgart, Germany
Anat Geva, Ph.D., Assistant Professor
Keith Kizzie, Major, US Army Medical Service Corps
Hilal Ozcan (Turkey)
Richard Rachdashel
Mardelle Shepley, Ph.D., Associate Professor
Keith Sylvester, Ph.D., Assistant Professor
Roger Ulrich, Ph.D., Professor

Clemson University
College of Architecture, Arts & Humanities
Member of GUPHA (Global University Programs in Health Care Architecture)

Professor David Allison, AIA, RA
Kevin Ahlers
Chery Bacsik
Katie Blake
Anthony Carmola
Maurie Dudenhadt
Shae Hensley
Matthew Nitch
Johnny Tam
Noah Tolson
Cherysse Yuan, China

The University of Tokyo
Department of Architecture
Founding Member of GUPHA
(Global University Programs in Healthcare Architecture)

Ms. Yukari Oka, Research Associate
Yasushi Nagasawa, Ph.D., Engineering Dip, HFP, JIA, Department of Architecture
Ami Aoki
Yuji Matsuda
Hiroshi Mizoguchi
Shunsuke Nei

Collaboration By:

John C. Webb Elementary School, Navasota, Texas
2ND and 3RD Grade Classes, Design Consultants on Children's Needs

Vanessa Nossa, Teacher
Consuelo Gonzales
Maria Gonzalez
Angelica Guzman
Kelly Holder
Rayshawn Jones
Daisy Mata
Beatriz Mena
Jasmine Montoya
Ivan Olvera
Magaly Padron
Daniel PiOon
David Rangel
Esmeralda Reyes
Genesis Rodriguez
Teresa Villasefior

Jane Long Middle School, Bryan, Texas
8TH Grade Class Design Consultants on Children's Needs

Lynette House, Teacher
Fatima Aguilar
Rebecca Armstrong
Erika Badillo
Mikel Bates
Babbi Benites
Crystal Castro
Jorge Conte
Francisco Gonzalez
Terrance Green
Angelica Guzman
Jessica Hansen
Lisa Herrin
Eliana Kozak
Juan Ledezma
Horacio Mendez
Rachael Molkentine
Patrick Montoya
Regulo Ortiz
Danny Reyes
Jamesa Terrell
Gabriela Tovar
Crystal Tucker
Michelle Tull
Lazaro Yanez

Sponsored By:
Children's Medical Center of Dallas
George D. Farr, President & Chief Executive Officer
Clara Salinas, Executive Assistant
Christie L. Cook, Administrative Assistant
John F. Dragovitz, Executive Vice President and Chief Operating Officer
Kathy Harper, RN, Project Director, Facilities Management Group
Marc E. Leedkar, AIA, Vice President, Facilities Management Group
William Marshall, CAD Manager, Facilities Management Group

HKS Architects
Dallas, Richmond, Los Angeles, Tampa, Orlando, Salt Lake City
Ronald L. Skaggs, FAIA, Chairman, CEO and President A.I.A. (American Institute of Architects-2000)
H. Ralph Hawkins, FAIA, Executive Vice President (Member Board AIA-Academy of Architecture for Health)
Joseph G. Sprague, FAIA, Senior Vice President & Director Health Facilities
Ron Dennis, AIA, Senior Vice President
Marc Badoux
Dwight Wiggins, AIA
Wesley Wong, AIA

CENTEX Construction Group
Brice E. Hill, President & CEO
Ken Bailey, COO

CENTEX Construction Company
Robert C. Van Cleave, President & CEO
Shannon Arnold, Senior Project Manager
Robert H. Gist, Vice President
Gary Kell, Vice President Healthcare Services
Robert S. Williams, Vice President Operations Corporate

.....for a series of presentations by Cooperative Interdisciplinary Teams utilizing the "Design / Build" Approach (Departments of Architecture, ConstructionScience, and Landscape Architecture and Urban Planning) for the New 720,000 Square Foot Expansion of Children's Medical Center of Dallas. Nine teams of undergraduate and graduate students will present their research design and construction proposals (programs, drawings and models).

Wednesday, December 8, 1999
4:30-6:30 PM
Children's Medical Center of Dallas
First Floor, Bright Building
1935 Motor Street
Dallas, Texas 75235

Please **RSVP** To: Christie L. Cook, Administrative Assistant
214-456-2536

College of Architecture
Texas A&M University
College Station, Texas 77843

children's MEDICAL CENTER OF DALLAS
HKS
CENTEX
Texas A&M University • College of Architecture

Invite y

Cover Graphic Design by Sean Murphy & Melissa Ross

APPENDIX C

(Fall 2003 Course details and Syllabus) Courtesy Dr. Anat Geva, Professor College of Architecture, Texas A&M University.

Texas A&M University
College of Architecture
ARCH 405 – 504: ***SACRED ARCHITECTURE***

Fall 2003

Dr. Anat Geva

PROJECT 2. **65% (650 points): All Faith House of God**

Issued: Wednesday October, 1
Due: Monday December, 8
Presentation: TBA

DESIGN BUILD PROJECT DELIVERY STUDIO
This project challenges students to work in teams of architecture and construction science to prepare a ***single source contract package*** for an owner. This package includes a design proposal, a conceptual project cost estimate, a conceptual project construction schedule, a cost-revenue curve, and value engineering analyses. The design-build studio simulates the professional practice where design-build becomes an important and viable construction project delivery option. The demand for a *single source of responsibility* that provides a seamless work environment between the design and construction teams, and the need for faster schedule delivery of the project contribute to the increased usage of design-build today. It should be noted that the outcomes as well as the processes of this studio differ from other educational endeavors that are labeled as *design-build,* which focus on actual construction of the projects and should be referred to as *design-construct*.

PROJECT STATEMENT
Visitors from all over the world that tour or vacation in tourist areas would like to be able to worship any time, or during special dates. Therefore, you are asked to design a 8,000 - 10,000 sq.ft building of an All Faith House of God in a specific tourist area in Texas.
The proposed All Faith House of God will be situated on the grounds of the …….(name)[2] The site of the project is approximately 431 acres and includes a Shuttle Station, and visitors parking area. The main entrance/exit to/from the site to the main road is in the east, while in the west there is an additional entrance/exit. Utility services are available from the powerhouse on site.

MATERIALS, EFFICIENCY, and BUILDING CODE

---

[2] Each group of two teams will select one of the following sites in Texas:
Palo Duro Canyon (near Amarillo, North Texas); ***Sabine National Forest*** (east Texas); ***Port Aransas*** (on the Golf, near Corpus Christi in south Texas); ***Alpine*** (Davis Mountains, West Texas)

In keeping with the overall goals of the clients, sustainable and efficient design is encouraged. Emphasize resource efficiency in construction (including recycled products where appropriate) and everyday use (including environmental control systems and response to climate). Implement construction and finish materials as well as appropriate systems to achieve the best value engineering. The requirements for protecting life, health and safety and for minimizing property damage must be incorporated into your solution, as well as all ADA requirements.

PROGRAM REQUIREMENTS:

- **Site requirements**

ROADS AND PATHS

Hiking and bike paths are marked on the site. Designate some of them to be used by shuttle buses to bring the visitors from the parking to the All Faith House of God.

PARKING AREA

Visitor and employee parking are provided on site near the entrance. However, your design should include the following:

- Shuttle bus parking - 2 cars
- Parking spots: - 10 cars: 5 reserved for employees; 2 for handicap; 3 for visitors. In addition you should provide a drop off/pick up drive way.

LANDSCAPE

Pedestrian access and circulation, vegetation, and special features.

- **Building requirements**

GENERAL

Your design solution should appeal to visitors from all nations/cultures representing different faith. **The total area of the building should be 8,000-10,000 gross sq.ft.,** (the area will not exceed 10,000 total gross sq.ft. an should not be less than 8,000 sq.ft) and will include three basic components of the program: Worship; Administration; and Service.

PROGRAM

- **WORSHIP WING**
- **Vestibule**
- **Sanctuary:** include a stage and a design to hold maximum 300 people
- **Indoor Reception area** (fellowship hall)
- **Outdoor Reception area** (not included in the building sq.ft.)
- **ADMINISTRATION WING**
- **A Library:** including a librarian office
- **2 Offices for clergy**: 1 for a secretary with an working area (for copy machine, fax, etc) and one for the director/leader of the House
- **1 Office for a counselor**
- **2-4 classrooms**
- **Storage**

- **1 employee toilet**

SERVICE WING

- **1 kitchenette**
- **Storage**
- **Janitor room**
- **Public Toilets (men/women)**
- **Mechanical room**

Note: It is anticipated that other incidental spaces will also be created. The number of these should be minimized and in all cases they must support and participate in the architectural idea.

PROJECT REQUIREMENTS, PROCEDURE, and SCHEDULE (see schedule and deliverable)
Teams consist of 2 ARCH, 2 COSC, and 1Graduate COSC.

PART Ia: Team's introduction, Mission Statement, and Team's web (4 teams of units of 2 teams)

All teams will sign a mission statement **(F. Oct. 3)** (ARCH 405; COSC 429)

Construct a team-web to include as the first phase: the team's mission statement, research and analyses **(F. Oct. 10)** (COSC 648)

PART Ib: Research, Analysis, and Synthesis (due: F. Oct. 10)

Procedure: (4 teams of units of 2 teams) (ARCH 405; COSC 429)

- Data collection, analyses and design guidelines (the potential implications of the information to the project).
- **Faith (Christianity, Judaism, Muslim, Buddhism & Hindu)**

- History and way of worship/rituals
- Dictation of religion/rituals for specific features in the worship place
- Examples of worship places in history including contemporary era (at least one example for each of the main denominations of each faith)
- Analyze each example in line of the following parameters and the specific requirements of the faith: sacred path/plan; vertical elements; holy light; acoustics; climate comfort.
- Prepare a set of guidelines for the design features that are most appropriate for each faith

Presentation:

- Prepare and present your report on the faith as a PowerPoint presentation of 20 mint. max:
  - on a zip or cd so that your information will be put on each team-web
  - 2 black and white hard copies of the report (one for the use of the class and one for Dr. Geva)

- **Location**

- Geography (maps; terrain; topography; soil and sub-surface conditions; weather conditions)
- Climate analysis (use the textbook of *Lechner* for climatic design guidelines for the project's climate zone)

- History and culture of the place
- Prepare a set of guidelines for a site plan, for important local cultural elements that should be incorporated into the design, and for "design with climate" (ARCH 405)
- Prepare a schematic site logistics plan (COSC 429)

Presentation:

- Prepare and present your report on the location as a PowerPoint presentation of 10 mint. max:
  - on a zip or cd so that your information will be put on each team-web
  - 2 black and white hard copies of the report (one for the use of the class and one for Dr. Geva)

- **Building Code**

- Building Code for this type of facility: fire, ADA, security, parking, and seating arrangements

Presentation:

- Prepare your report on building code as a class booklet

General instructions for presentations:

- Reports and analysis must be brief and to the point, clearly prepared with all pertinent information, and well presented.
- All submissions will have a cover page (slide) that will include the topic of your investigation, your full names, the date, the class name, and the instructors names
- All submissions will have a full reference as the last page (slide)

PART II: Architectural Concept, Operational Objectives (W. Oct. 15)

Procedure and Presentation (individual teams)

ARCH 405: Prepare architectural concept, operational objectives, and first conceptual sketches

- Type and draw this information on 81/2x11
- All submissions will have a Standard Identification.

COSC 648: Post this information on the team's web site

PART III: Preliminary Design (W. Nov. 12: presentation; F. Nov. 14: discussion with COSC and clients)

ARCH 405 (team of 2): Use the information collected in Part I to prepare your preliminary design.
Procedure:

(a) Function

(b) Circulation
(c) Image

- The preliminary presentation will be prepared on tracing paper
- The preliminary presentation will include a set of drawings of all relevant information for communicating your design ideas:

- the project concept and its operational objectives
- site circulation diagrams and site plan (1/16"=1-0')
- site section including the proposed building (1/16"=1-0')
- floor plans and circulation diagrams (1/8"=1-0')
- main entrance elevation ((1/8"=1-0')
- one section of the building (1/8"=1-0') including suggested structural and environmental systems an construction and finish materials
- preliminary ENER-WIN simulations

- All submissions will have a standard ID, north arrow, and scale
- You'll present your preliminary design to the class, and the client and discuss the design, systems, materials and safety with the COSC students

COSC 429 (team of 2): Following the discussion with ARCH 405 prepare:

- Preliminary construction schedule
- Preliminary construction cost estimate
- Sections and material selections
- Preliminary value engineering for materials, systems (structure, energy, and construction)

COSC 648: Manage the team meetings and discussions

- Based on joint team ideas establish logo and post on the team-web
- Post preliminary design, schedule and cost estimate on the team-web

PART IV: Final submission and presentation (Due: M. Dec. 8; Presentation: Dec. TBA)

Procedure: (ARCH 405, COSC 429, COSC 648)
Based upon comments and criticism of your preliminary composition, revise your design. Work very closely with your team members. Prepare the final presentation of the project as **a team of Design-Build**
Presentation: The final submission will include the following:

- Team logo
- Architectural concept
- At least one perspective of the project (exterior and/or interior)
- Cost estimate and Bid Package
- Site plan (1/16"=1-0') showing the relationship of surrounding development, landscaping, and circulation patterns;
- Site section including the proposed building (1/16"=1-0') showing physical and visual relationships as appropriate
- Construction site logistics plan (1/16"=1-0')
- Floor(s) plan(s) (1/8"=1-0')
- Four elevations (1/8"=1-0')
- Two sections (1/8"=1-0') including
- A wall section illustrating the architectural/structural use of materials in the design solution

- ENERWIN simulation results
- Value engineering analyses including energy values
- Construction Schedule Projection
- Cost Revenue curve

Please submit the material in the following format:

- A booklet of 81/2x11 (copies for: clients, instructors, your team members)
- A Power Point presentation on a Zip/CD. The length of the presentation should be 15 minutes max.
- Graduate student will post the presentation on the team's web-site

PROJECT EVALUATION

Research and Analysis **100**

Design **250**

- General impression
- Design concept and image
- Program requirements:
- Site Plan and section
- Functions
- Circulation
- Design with concrete
- Building's systems (structure, mechanical)
- Efficiency (circulation, energy, ecology)
- Building Code (fire, handicap, concrete)

Team work **50**

Quality of Presentation **250**

- Oral
- PowerPoint and web
- Booklet

APPENDIX D

(Fall 2003 Course Deliverables) Courtesy Dr. Anat Geva & Dr. Charles Graham, Professor College of Architecture, Texas A&M University.

DESIGN-BUILD CLASS PROJECT: ARCH 405; COSC 429; CO SC 648
Fall 2003

Activity	Assignment	ARCH Students	COSC 429	COSC 648	Remarks
1	Design for All Faith House of God in Texas	Conduct research, prepare preliminary design concepts	Observe, become familiar with scope of work	prepare team's web-site	Create team environment, set milestones, integrate components
2	Team Mission Statement	Participate in team meeting. COSC students to take lead in mission statement preparation	Brief exercise of team members for students to get acquainted, write a brief team mission statement	Coordinate development of team mission statements; post on web	Select a team leader. Prepare a team mission statement as per typical partnering guidelines. Exchange telephone and e-mail numbers. Find common meeting times.
3	Start preliminary design	Start design drawings, models	Provide research support for wall sections, mechanical systems, finishes	Observe, become familiar with scope of work	Begin preliminary design work
4	Team Web Site	Take lead in graphic design, layout	Organize data management and information flow models	Get permissions, passwords and set up web site	Prepare and use a team web site; document team meeting minutes, team data, design information.
5	Conceptual Cost Estimate	Provide preliminary design information about buildings, site improvements to COSC and NUEN team members	Prepare a conceptual cost estimate	Provide a peer review, advise in preparation of conceptual cost estimate	Set up a conceptual cost estimating system on the computer; spreadsheet that can easily be changed as the design evolves. Use square foot costs per each CSI Division to get a total cost. Understand construction and design processes. Use preliminary design drawings, and safety measurments
6	Conceptual Project Schedule	Provide preliminary design information about buildings, site improvements to COSC and NUEN team members	Prepare a conceptual project schedule	Provide a peer review, advise in preparation of conceptual schedule	Use a simplified method to represent activities during months of project. Estimate overall project duration.
7	Preliminary Design and Logo	Produce preliminary design of buildings and logo	Assist with preliminary design presentation and design of logo	Assis with preliminary design presentation and design of logo	Present preliminary design results to get feedback from classmates, faculty, for further refinement; also, provide a logo design for the team, web site
8	Value Engineering	Provide preliminary design information about buildings, site improvements to COSC team members	Conduct analysis of life-cycle costs of the foundation, structural system, envelope and selected equipment	Collect results for web site	Materials and methods references; equipment and furnishings specifications; knowledge of local construction conditions; climate etc.
9	Bid Packages	Refined design drawings; Help with identification of CSI Divisions	Grouping of activities and subcontractors activities into logical bid packages	Peer review of bid package contents	Refined design drawings needed; CSI Divisions need to be identified.
10	Refined Cost and Schedule Projections	Refined design drawings	Revise and fine tune the conceptual cost and schedule projections in response to refined design drawings	Peer review of cost and schedule projections	Update conceptual cost estimates and project schedule
11	Energy analyses	use ENERWIN to evaluate the compatibility of your design to the local climate	Use value engineering for energy efficiency	coordinate team work and post results on the web	Include morphological analyses of deign with climate according to climatic design guidelines
12	Site Logistics Plan	Prepare architectural site plan with proposed construction, existing traffic circulation plan around property, site access points, signalization and signage around the site	Prepare construction site logistics plan showing site access, contractor lay down, storage, trailer park, material deliveries, temporary traffic, temporary signage, contractor parking, guest parking, crane and hoist locations etc.	Peer review of site logistics plan	COSC students should use the site plan provided by the designer to prepare this plan. Use graphic representation and provide a legend and notes as required to fully explain site logistics. Conduct research into site logistics planning.

13	Final Presentation	Provide architectural information for preparation of booklet, design drawings, PowerPoint presentation. Produce final design drawings.	Design-Build Team's Data Booklet	Final web site contents must be current and ready for demonstration.	Jurors. Presentation with question and answer period. D-B Team's Data Booklet shall be 8.5"x11" and shall contain an architectural site plan, schematic floor plans, schematic elevations, building sections, value engineering indices and recommendations, bid packages, cost estimate, project schedule, and site logistics plan. Provide with a nice cover and bind.
14	Project Evaluation	Evaluation of project by ARCH students	Evaluation of project by COSC students	Evaluation of project by COSC students	Project evaluation form. Analysis of feedback. Team leader to coordinate with instructors.

Note: See Schedule for important dates

APPENDIX E

TEXAS A&M UNIVERSITY HUMAN SUBJECTS PROTECTION PROGRAM

INFORMATION SHEET

Identification of long-term learning outcomes and opportunities for improvement from an interdisciplinary course in Architecture, Engineering and Construction environment.

You are invited to take part in a research study being conducted by Nivedita Kalyanaraman a researcher from Texas A&M University. The information in this form is provided to help you decide whether or not to take part. If you decide you do not want to participate, there will be no penalty to you, and you will not lose any benefits you normally would have.

Why Is This Study Being Done?

The purpose of this study is to identify long term learning outcomes that alumni students retain from interdisciplinary course in Architecture, Engineering and Construction environment and suggest opportunities for improvement in such courses in the future.

Why Am I Being Asked To Be In This Study?

You are being asked to be in this study because you have been identified as an alumni student from one of the two interdisciplinary studio courses (Fall 1999 or Fall 2003)

offered between Department of Architecture and Construction science at Texas A&M University.

How Many People Will Be Asked To Be In This Study?

108 people (participants) who have been a part of either of the 2 interdisciplinary studio course taught at Texas A&M University during either Fall 1999 or Fall 2003 will be invited to participate in this study.

What Are the Alternatives to being in this study?

No, the alternative to being in the study is not to participate.

What Will I Be Asked To Do In This Study?

You will be asked to either fill out a set of survey questions or phone interviewed. The set of questions would include about your educational background, your current career role, about the particular course implication, how it is used in your day to day life and what are things that you would like to improve in such interdisciplinary courses. Your participation in this study will last up to 20- 30 minutes just one time.

Are There Any Risks To Me?

The things that you will be doing are no more risks than you would come across in everyday life. Although the researchers have tried to avoid risks, you may feel that some

questions/procedures that are asked of you will be stressful or upsetting. You do not have to answer anything you do not want to.

Will There Be Any Costs To Me?

Aside from your time, there are no costs for taking part in the study

Will I Be Paid To Be In This Study?

You will not be paid for being in this study.

Will Information From This Study Be Kept Private?

The records of this study will be kept private. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be stored securely and only the Principal investigator – Dr. Zofia Rybkowski and Protocol Director– Nivedita Kalyanaraman will have access to the records.

Information about you will be stored in computer files protected with a password.

Information about you will be kept confidential to the extent permitted or required by law. People who have access to your information include the Principal Investigator and research study personnel. Representatives of regulatory agencies such as the Office of Human Research Protections (OHRP) and entities such as the Texas A&M University

Human Subjects Protection Program may access your records to make sure the study is being run correctly and that information is collected properly.

Who may I Contact for More Information?

You may contact the Principal Investigator, Dr. Zofia Rybkowski, PhD, MS (Civil, Environmental Engineering) M. Phil (Civil Engineering), M.Arch (Architecture), MS (Biology), BS (Biology) to tell her about a concern or complaint about this research at 979-845-4354 or zrybkowski@tamu.edu.

You may also contact the Protocol Director, Nivedita Kalyanaraman at 618-303-9044 or nivedita_88@tamu.edu. For questions about your rights as a research participant; or if you have questions, complaints, or concerns about the research, you may call the Texas A&M University Human Subjects Protection Program office at (979) 458-4067 or irb@tamu.edu.

What if I Change My Mind About Participating?

This research is voluntary and you have the choice whether or not to be in this research study. You may decide to not begin or to stop participating at any time. If you choose not

to be in this study or stop being in the study, there will be no effect on your employment or relationship with Texas A&M University.

By participating in the interview or completing the survey, you are giving permission for the investigator to use your information for research purposes.

Thank you.

Nivedita Kalyanaraman

Graduate Student (Masters in Construction Management)

Texas A&M University

IRB NUMBER: IRB2015-0196D

IRB APPROVAL DATE: 03/31/2015

IRB EXPIRATION DATE: 03/15/2016

I wish to participate in this research study

- ❍ Yes (1)
- ❍ No (2)

SECTION 1: EDUCATIONAL BACKGROUND

Q 1 Please confirm that you took the interdisciplinary studio course between Architecture, Construction Science, which was offered in the fall of 1999 or fall 2003 at Texas A&M University

- ❍ Yes, I took the course (1)
- ❍ No, I did not take the course (2)

Q 2 If you answered "Yes" to the previous question, which of the following course did you take.

- ❍ Fall 1999 (1)
- ❍ Fall 2003 (2)

Q 3 What is your maximum level of education?

- ❍ Associate Degree (1)
- ❍ Bachelor's Degree (2)
- ❍ Master's Degree (3)
- ❍ PhD Degree (4)
- ❍ Other (5) _____

Q 4 What was your major in the undergraduate program?

- ❍ Construction Science (1)
- ❍ Architecture (2)
- ❍ Landscape Architecture (3)
- ❍ Other If other please specify (4) _____

Q 5 What was your major in the master/ post graduate program? (If applicable)

- ❍ Construction Science (1)
- ❍ Architecture (2)
- ❍ Landscape Architecture (3)
- ❍ Other If other please specify (4) _____

Q 6 If you have additional degrees please explain here:

Q 7 Was the interdisciplinary studio between Architecture and Construction management taught at Texas A&M University in the fall of 1999 or fall 2003, a part of your

- ❍ Undergraduate Degree? (1)
- ❍ Master's Degree? (2)

SECTION 2: PROFESSIONAL BACKGROUND

Q 1 Which of the following roles do you currently represent in your career?

- ❍ Owner (1)
- ❍ Architect/ Designer
- ❍ Contractor/ Sub- Contractor
- ❍ Project manager
- ❍ Other If other please specify _____

Q 2 How many years of experience do you possess in the field of Architecture, Engineering, Construction or related industries?

- ❍ 0-5 years
- ❍ 6- 10 years
- ❍ 11- 15 years
- ❍ 16- 20 years
- ❍ > 20 years

Q 3 What are your current roles and responsibilities at your work place?

SECTION 3: INTERDISCIPLINARY COURSE:

The following questions are related to the interdisciplinary studio course between Architecture and Construction Science, which was offered in the fall of 1999 or fall 2003 at Texas A&M University. Please answer the following questions to the best of your recollection.

Q 1 How were the project's teams determined?

Q 2 On a scale of 1-5 (with 1 being not comfortable and 5 being very comfortable) how would you rate working with your teammates during the INITIAL phase of the project?

- ❍ Not comfortable (1)
- ❍ Somewhat comfortable (2)
- ❍ Comfortable (4)
- ❍ Very Comfortable (5)

Q 3 How often did you meet as a team, outside of class to work on the project?

- ❍ Daily (1)
- ❍ Weekly once (2)
- ❍ Bi weekly once (3)
- ❍ Monthly once (4)
- ❍ Never met (5)
- ❍ Other (if other, please explain) (6) _____

Q 4 Did you use a specific strategy as a team to collaborate and work?

- ❍ Yes (1)
- ❍ No (2)

If YES please explain the strategy, if NO please explain how you worked as a team.

Q 5 Did you face any challenges working as a team?

- ❍ Yes (1)
- ❍ No (2)

If YES, please explain the challenges faced during the project.

Q 6 Please list 5 of the most important things that you learned from this interdisciplinary studio course

1 _____

2 _____

3 _____

4 _____

5 _____

Q 7 On a scale of 1-5 (with 1 being not comfortable and 5 being very comfortable) how would you rate working with your teammates during the FINAL phase of the project?

- ❍ Not comfortable (1)
- ❍ Somewhat comfortable (2)
- ❍ Comfortable (4)
- ❍ Very comfortable (5)

Q 8 Was real world scenario adopted in the course project?

- ❍ Yes (1)
- ❍ No (2)

If YES, please explain how it was adopted in the course project.

_____

SECTION 4: CAREER IMPLICATIONS

Q 1 Does your work involve collaboration in your day to day activities

- ❍ Yes (1)
- ❍ No (2)

If YES, please specify how,

Q 2 How you would rate each of the following learning benefits from the

interdisciplinary course as it affects your career now or in the past?

	Ranking					Please give suitable examples
	Highly Beneficial (5)	Moderately Beneficial (4)	Beneficial (3)	Less Beneficial (2)	Not so beneficial (1)	(a few words)
Teamwork (1)	❍	❍	❍	❍	❍	
Creative Thinking (2)	❍	❍	❍	❍	❍	
Trust Building (3)	❍	❍	❍	❍	❍	
Decision Making (4)	❍	❍	❍	❍	❍	
Negotiating Skills (5)	❍	❍	❍	❍	❍	
Leadership Skills (6)	❍	❍	❍	❍	❍	
Communication Skills (7)	❍	❍	❍	❍	❍	

Time Management (8)	❍	❍	❍	❍	❍	
People Management (9)	❍	❍	❍	❍	❍	

Q 3 How did the coursework impact your strategy that you use in your workplace while working as a team?

SECTION 5: RETROSPECTION

Q 1 Were there any parts of the course that especially helped you in your work life after graduation? Please give examples.

Q 2 Was there anything you feel should be included in FUTURE in an interdisciplinary course? Or anything that you would recommend to change based on your work experience. Please give example/ examples.

Q 3 Would you suggest more interdisciplinary courses in the curriculum for Architecture, Engineering, Construction and other fields?

- ❍ Yes (1)
- ❍ No (2)

Please explain why?

APPENDIX F

IRB OUTCOME LETTER

DIVISION OF RESEARCH

Research Compliance and Biosafety

TEXAS A&M UNIVERSITY

DATE: March 31, 2015

MEMORANDUM

TO: Zofia K Rybkowski, PhD
TAMU - College Of Architecture - Construction Science

FROM: Dr. James Fluckey
Chair
Institutional Review Board

SUBJECT: Expedited Approval

Study Number: IRB2015-0196D

Title: Identification of long-term outcomes and opportunities for improvement from an interdisciplinary course in Architecture, Engineering and Construction environment.

Approval Date: 03/31/2015

Continuing Review Due: 02/15/2016

Expiration Date: 03/15/2016

Documents Reviewed and Approved:

Submission Components			
Study Document			
Title	Version Number	Version Date	Outcome
SURVEY questions	Version 1.1	03/16/2015	Approved
SURVEY questions	Version 1.0	03/16/2015	Void
Study Consent Form			
Title	Version Number	Version Date	Outcome
Telephonic interview script	Version 1.0	03/31/2015	Approved
Consent - Information Sheet 3.16.2015	Version 1.0	03/16/2015	Approved

Document of Consent: Partial waiver approved under 45 CFR 46.117 (c) 1 or 2/ 21 CFR 56.109 (c)1

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APPENDIX G

RECRUITING EMAIL

TEXAS A&M UNIVERSITY

Dear Former Student,

You are invited to participate in an online survey about "Long term learning outcomes from interdisciplinary course between Architecture, Construction Science and Engineering". This survey is being conducted by graduate student Nivedita Kalyanaraman from the department of Construction Science at Texas A&M University for her research purpose.

I am surveying about 108 students from the College of Architecture at Texas A&M University from the batch of Fall 1999 and Fall 2003, who have taken interdisciplinary course between Architecture, Construction Science, ENDS and Landscape Architecture either during their undergraduate or graduate course program. The Association of Former Students at Texas A&M University is distributing this email on my behalf.

This table below would help you remember the course based on the professor in charge for the course during that particular year.

COURSE	ENDS	ARCHITECTURE	CONSTRUCTION SCIENCE	CONSTRUCTION MANAGEMENT	LANDSCAPE
FALL 1999	Dr. George Mann, Dr. Rodney Hill,	Dr. George Mann, Dr. Thomas L McKittrick	Dr. James Smith, Dr. John Bryant	Dr. James Smith	Dr. Harlow C. Landphair
FALL 2003	Dr. Anat Geva	Dr. Anat Geva	Dr. James Smith	Dr. James Smith	

Your answers will be treated as completely confidential. We will not release any information that would identify you as a survey participant or let anyone know how you answered the survey questions. The survey will take about 20 minutes of your time.

Please visit the following URL in your browser to begin the survey:
https://tamu.qualtrics.com/SE/?SID=SV_3ORGnWlRUod9hcx

The information that we collect will only be used by researcher to determine how alumni students perceive outcomes of an interdisciplinary course in Architecture, Engineering, and Construction background and to identify how these courses need to be improved for benefitting the industry. You are free to not answer any questions that you choose. If a question makes you uncomfortable, please leave it blank.

For survey-related questions and clarifications, please contact the Principal Investigator, Dr. Zofia Rybkowski, PhD, MS (Civil, Environmental Engineering) M. Phil (Civil Engineering), M.Arch (Architecture), MS (Biology), BS (Biology) to tell her about a concern or complaint about this research at 979-845-4354 or zrybkowski@tamu.edu. You may also contact the Protocol Director, Nivedita Kalyanaraman at 618-303-9044 or nivedita_88@tamu.edu.

Please note that this research study has been reviewed by The Institutional Review Board - Human Subjects' Protection Program at Texas A&M University. For research-related problems or questions regarding your rights as a research participant, you can contact this office at (979) 458-4067 or irb@tamu.edu.

DUE DATE: Please send in your response to the survey on or before May 12th 2015, 11.59 pm Central Time (CT).

Thank you for your time and attention.

Nivedita Kalyanaraman *Graduate Student (Masters in Construction Management)*

Texas A&M University

IRB NUMBER: IRB2015-0196D
IRB APPROVAL DATE: 08/31/2015
IRB EXPIRATION DATE: 03/15/2016